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(54) Method and apparatus for reducing premature termination of mobile station LCS procedure during RR operations

(57) A method is disclosed for operating a mobile station in cooperation with a network operator, as is a system including the mobile station and the network operator. The method operates, upon an occurrence of a RR procedure, including HO and CRS, that affects the mobile station, to determine if a location procedure is ongoing in the mobile station and, if it is, to complete the location procedure and to report the measurement results (which may be a failure indication) in a message from the mobile station to a target radio network controller. The location procedure may be, for example, a LCS procedure executed during a Combined Hard Handover and SRNS Relocation procedure for a PS and CS domain, and applies to both intra-SGSN SRNS relocation and for inter-SGSN and SRNS relocation. The location procedure may also be, for example, a LCS procedure executed during a Combined Cell/URA/GRA Update and SRNS Relocation procedure for the PS domain, and also applies to both intra-SGSN SRNS relocation and for inter-SGSN SRNS relocation. When the location procedure is a LCS procedure, the method further sends LCS parameters from a source RNC to the target RNC. The LCS parameters can be sent in a Source RNC to Target RNC Transparent Container in a Relocation Required message, or in a Relocation Commit message, or in a Forward SRNS Context message. The measurement results message may be sent by the mobile station before or after sending a UTRAN Mobility Information Confirm message from the mobile station to the target RNC/BSC.

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Description

TECHNICAL FIELD:

[0001] These teachings relate generally to wireless communications systems and, more specifically, to procedures for determining a location or a position of a mobile station (MS) within the wireless network (NW).

BACKGROUND:

[0002] The following abbreviations are herewith defined.

3G	Third Generation (cellular system)
A/Gb mode	Mode of operation of MS when connected to the core network via GERAN and the A and/or Gb interfaces
BSC	Base Station Controller
BTS	Base Transceiver Station
CN	Core Network
CRS	Cell Re-Selection
CS	Circuit Switched
DL	Down Link (to the MS)
EDGE	Enhanced Data rate for Global Evolution
E-OTD	Enhanced-Observed Time Difference
GERAN	GSM/EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GMLC	Gateway Mobile Location Center
GPS	Global Positioning System
GRA	GERAN Registration Area
GSM	Global System for Mobile Communications
GTP	GPRS Tunneling Protocol
HO	Handover
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
Iu mode	Mode of operation of MS when connected to the core network via GERAN or UTRAN and the Iu interface
Iur	A logical interface between two RNC
Iur-g	A logical interface between two BSCs
LCS	Location Services
ME	Mobile Equipment
MM	Mobility Management
MS	Mobile Station
MSC	Mobile Switching Center
NAS	Non-Access Stratum
PDCP	Packet Data Convergence Protocol
PDP	Packet Data Protocol
PDU	Packet Data Unit
PS	Packet Switched
QoS	Quality of Service
RAB	Radio Access Bearer
RAN	Radio Access Network
RANAP	Radio Access Network Application Part
RNC	Radio Network Controller
RNTI	Radio Network Temporary Identity
RR	Radio Resources
RRC	Radio Resource Control
RRLP	Radio Resource Location Procedure
SGSN	Serving GPRS Support Node
SMLC	Serving Mobile Location Center
SRNS	Serving RNS
UE	User Equipment
UL	Uplink (from the MS)

UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
UTRAN	Universal Terrestrial Radio Access Network
VMSC	Visited MSC

[0003] Reference can also be made to 3GPP TR 21.905, V4.4.0 (2001-10), Third Generation Partnership Project; Technical Specification Group Services and System Aspects; Vocabulary for 3GPP Specifications (Release 4).

[0004] Over the period of a decade the GSM standard has evolved from a basic voice service to a wide variety of speech and data services. In the 3GPP Release 5 the functional split between the GSM/EDGE Radio Access Network (GERAN) and the core network (CN) will be aligned with the functional split between UTRAN and the CN, thereby enabling GERAN to connect to the same 3G core network and to provide the same set of services as UTRAN. This functionality split implies a new architecture for GERAN and significant modifications to the GERAN radio protocols.

[0005] Several new interfaces such as Iu and Iur-g are defined for the GERAN architecture. The Iu interface is common between UTRAN and GERAN. An Iu-ps and Iu-cs interface is being considered, where Iu-ps is the interface targeted for the packet switched (PS) domain, and Iu-cs is the interface targeted towards the circuit switched (CS) domain. Both of these interfaces will be supported by the GERAN specifications. The Iur-g is the interface between two GERANs, and supports signaling information between them (note that the Iur-g is currently planned to support only the control plane procedures of Iur).

[0006] A Mobile Station (MS) can be attached to the core network through either the Iu-cs or Iu-ps, or through both the Iu-cs and Iu-ps interfaces. The MS can also be attached to the CN through the legacy interfaces A and Gb. As a result, the GERAN Radio Resource Control (RRC) protocol is based on both the GSM Radio Resource (RR) and the UTRAN RRC specifications. The MS can operate in either the A/Gb mode or the Iu mode. The A/Gb mode is defined for the MS when connected to a GERAN with no Iu interface towards the CN. The Iu mode is defined for the MS when connected to a GERAN with Iu interfaces towards the CN.

[0007] UMTS has a standardized relocation procedure that is expected will be used as well in the GERAN Iu mode. Figs. 1 and 2 illustrate the relocation procedure, and can be found as well in the standard 3G TS 23.060, V4.2.0 (2001-10), Third Generation Partnership Project; Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service Description; Stage 2 (Release 4). More specifically, Fig. 2 shows the operation of the currently specified Combined Hard Handover and SRNS Relocation procedure for the PS domain. The illustrated sequence is valid for both intra-SGSN SRNS relocation and for inter-SGSN and SRNS relocation. Fig. 3 shows the operation of a Combined Cell /URA Update and SRNS Relocation procedure for the PS domain. This sequence is valid for both intra-SGSN SRNS relocation and for inter-SGSN SRNS relocation. The Cell Update and Relocation procedures have been accepted by standardization committees to be adopted from UTRAN to GERAN Iu mode.

[0008] According to current GSM specifications (Release 1998 (R98) and Release 1999 (R99), GSM 03.71), the E-OTD and GPS MS positioning procedures are terminated in the case of handover, or upon the occurrence of some other RR management procedure. More specifically, what is currently specified is that:

> The BSC shall terminate any network or MS positioning procedure or any transfer of RRLP assistance data already in progress if inter-BSC or inter-MSC handover is needed and is not precluded by the particular location procedure and its current state.

> The BSC shall terminate any network or MS positioning procedure or any transfer of RRLP assistance data already in progress if an intra-BSC handover or other intra-BSC RR management procedure is needed and is not precluded by the particular location procedure and its current state.

[0009] As may be appreciated, the current approach results in GPS and E-OTD positioning procedures being terminated in many cases due to HO or some other RR procedure, requiring the VMSC (or the GMLC) to restart the MS positioning procedure. This results in additional delays, as well as in an increased MS power consumption, and the in some cases the entire positioning operation may fail within the time specified by an application.

SUMMARY OF THE PREFERRED EMBODIMENTS

[0010] The foregoing and other problems are overcome, and other advantages are realized, in accordance with the presently preferred embodiments of these teachings.

[0011] These teachings pertain to Assisted GPS, E-OTD and other suitable location methods and systems and provide a technique to avoid undesired termination of a LCS procedure due to some RR procedure (e.g., HO or CRS). The LCS process and the supplying of its associated parameters are moved when required from a current serving BSC/RNC/SMLC and MSC/SGSN to a new serving entity with a relocation procedure. These teachings are applicable,

for example, to GERAN Iu mode standards as well as to UTRAN standards, and may be applied as well to the GERAN A/Gb mode, while possibly requiring a new interface between BSCs (comparable to the Iur-g interface in the Iu mode) when operating in the A/Gb mode.

[0012] A method is disclosed for operating a mobile station in cooperation with a network operator, as is a system including the mobile station and the network operator. The method operates, upon an occurrence of a RR procedure, including HO and CRS, that affects the mobile station, to determine if a location procedure is ongoing in the mobile station and, if it is, to complete the location procedure and to report the measurement results (which may be a failure indication) in a message from the mobile station to a target radio network controller. The location procedure can be, in accordance with an embodiment of this invention, a LCS procedure that is executed during a Combined Hard Handover and SRNS Relocation procedure, for both the PS and CS domains, and applies to both intra-SGSN/MSC SRNS relocation and inter-SGSN/MSC and SRNS relocation. The location procedure can also be, in accordance with another embodiment of this invention, a LCS procedure that is executed during a Combined Cell/URA Update and SRNS Relocation procedure for the PS domain, and also applies to both intra-SGSN SRNS relocation and for inter-SGSN SRNS relocation

[0013] For the LCS procedure, the method further sends LCS parameters from a source RNC/BSC to the target RNC/BSC. The LCS parameters in this case are sent in a Source RNC to Target RNC Transparent Container in a Relocation Required message (note should be made that the name of this container is UTRAN specific, and that it may be referred to differently in, for example, GERAN). LCS parameters may also be sent from the source BSC/RNC to the target BSC/RNC in a Relocation Commit (SRNS Contexts) message or, if no Iur(-g) is available, in a Forward SRNS Context message. Note in this case that the reference to Iur-g is GERAN specific, but should not be viewed as being a limitation upon the practice of this invention.

[0014] The LCS parameters can include at least one of (i) a requested location accuracy; (ii) a requested location response time; (iii) details pertaining to a currently ongoing location process; and (iv) a GMLC address.

[0015] The measurement results message may be sent by the mobile station before or after sending a GERAN/UTRAN Mobility Information Confirm message from the mobile station to the target BSC/RNC.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The foregoing and other aspects of these teachings are made more evident in the following Detailed Description of the Preferred Embodiments, when read in conjunction with the attached Drawing Figures, wherein:

Fig. 1 is a block diagram of a wireless communications system that is suitable for practicing these teachings;

Fig. 2 illustrates the operation of a conventional Combined Hard Handover and SRNS Relocation procedure for the PS domain, where the illustrated sequence is valid for both intra-SGSN SRNS relocation and for inter-SGSN and SRNS relocation;

Fig. 3 illustrates the operation of a conventional Combined Cell/URA Update and SRNS Relocation procedure for the PS domain, where the illustrated sequence is valid for both intra-SGSN SRNS relocation and for inter-SGSN SRNS relocation;

Fig. 4 illustrates the operation of the relocation procedure with LCS data for the case of Cell Reselection (PS domain) in accordance with the teachings of this invention; and

Fig. 5 is a logic flow diagram that illustrates an LCS Relocation in an IP RAN architecture in accordance with a further aspect of these teachings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Referring first to Fig. 1, there is illustrated a simplified block diagram of an embodiment of a wireless communications system 5 that is suitable for practicing this invention. The wireless communications system 5 includes at least one mobile station (MS) 100, also referred to herein as User Equipment (UE). Fig.1 also shows an exemplary network operator having, for example, a Serving GPRS Support Node (SGSN) 30 for connecting to a telecommunications network, such as a Public Packet Data Network or PDN, at least one base station controller (BSC) 40, and a plurality of base transceiver stations (BTS) 50 that transmit in a forward or downlink direction both physical and logical channels to the mobile station 100 in accordance with a predetermined air interface standard. A reverse or uplink communication path also exists from the mobile station 100 to the network operator, which conveys mobile originated access requests and traffic.

[0018] When the MS 100 moves from a cell served by a first BTS 50 to a cell served by another BTS 50, when both are controlled by the same BSC 40, an inter-BSC handover (HO) is executed. However, the MS 100 may also transition between cells served by BTSs 50 that are individually controlled by different BSCs 40. In this case the HO is considered to be an intra-BSC HO.

[0019] The air interface standard can conform to any suitable standard or protocol, and may enable both voice and data traffic, such as data traffic enabling Internet 70 access and web page downloads. In the presently preferred embodiment of this invention the air interface standard is a Time Division Multiple Access (TDMA) air interface that supports a GSM or an advanced GSM protocol and air interface, although these teachings are not intended to be limited to TDMA or to GSM or GSM-related wireless systems.

[0020] The network operator may also include a suitable type of Message Center (MC) 60 that receives and forwards messages for the mobile stations 100. Other types of messaging service may include Supplementary Data Services and one under currently development and known as Multimedia Messaging Service (MMS), wherein image messages, video messages, audio messages, text messages, executables and the like, and combinations thereof, can be transferred between the network and the mobile station 100.

[0021] The mobile station 100 typically includes a microcontrol unit (MCU) 120 having an output coupled to an input of a display 140 and an input coupled to an output of a keyboard or keypad 160. The mobile station 100 may be a handheld radiotelephone, such as a cellular telephone or a personal communicator. The mobile station 100 could also be contained within a card or module that is connected during use to another device. For example, the mobile station 10 could be contained within a PCMCIA or similar type of card or module that is installed during use within a portable data processor, such as a laptop or notebook computer, or even a computer that is wearable by the user.

[0022] The MCU 120 is assumed to include or be coupled to some type of a memory 130, including a read-only memory (ROM) for storing an operating program, as well as a random access memory (RAM) for temporarily storing required data, scratchpad memory, received packet data, packet data to be transmitted, and the like. A separate, removable SIM (not shown) can be provided as well, the SIM storing, for example, a preferred Public Land Mobile Network (PLMN) list and other subscriber-related information. The ROM is assumed, for the purposes of this invention, to store a program enabling the MCU 120 to execute the software routines, layers and protocols required to implement the improved MS LCS procedure n accordance with these teachings, as well as to provide a suitable user interface (UI), via display 140 and keypad 160, with a user. Although not shown, a microphone and speaker are typically provided for enabling the user to conduct voice calls in a conventional manner.

[0023] The mobile station 100 also contains a wireless section that includes a digital signal processor (DSP) 180, or equivalent high speed processor or logic, as well as a wireless transceiver that includes a transmitter 200 and a receiver 220, both of which are coupled to an antenna 240 for communication with the network operator. At least one local oscillator (LO) 260, such as a frequency synthesizer, is provided for tuning the transceiver. Data, such as digitized voice and packet data, is transmitted and received through the antenna 240.

[0024] It has been realized that the termination of the positioning procedure is in most cases unnecessary, but may be required, as the MS 100 is expected to behave in the same manner for both intra-BSC and inter-BSC HOs, i.e., the MS 100 does not typically know *a priori* when the BSC 40 will be changed during the HO procedure. In all cases in the following Table the positioning procedure is terminated according to current specifications. In the Table are also listed what kind of effects the HO or other RR procedure has on the LCS, and what is required to be done in order to continue the LCS procedure.

Positioning method	RR Procedure	Effect on positioning measurement process	Actions required to continue positioning procedure
(Assisted) GPS	Inter MSC/SGSN handover/ CRS	None*#	New serving BSC/SMLC and MSC/SGSN needs to be informed about the ongoing positioning procedure and its parameters (or the MS's response should be send to previous SMLC and MSC/ SGSN).
	Inter BSC handover/CRS (Intra MSC or SGSN)		New serving BSC/SMLC needs to be informed about the ongoing positioning procedure and its parameters (or the MS's response should be send to old SMLC).
	Intra BSC handover/CRS		Nothing
	Other RR management procedure (=Intra Cell procedure)	None	Nothing
E-OTD	Inter MSC/SGSN handover/ CRS	Assistance data delivered to MS is not valid anymore. But there is possibility that the MS has already managed to make the majority of the measurements, or MS can internally convert the assistance data to new serving BTS, and the amount of new neighbor BTSs is small, in these cases it would be still possible to continue the measurement procedure in MS under the new serving BTS. #	New serving BSC/SMLC and MSC/SGSN needs to be informed about the ongoing positioning procedure and its parameters (or the MS's response should be send to old SMLC and MSC/SGSN).
	Inter BSC handover/CRS (Intra MSC or SGSN)		New serving BSC/SMLC needs to be informed about the ongoing positioning procedure and its parameters (or the MS's response should be send to the previous SMLC).
	Intra BSC handover/CRS		Nothing
	Other RR management procedure (=Intra Cell procedure)	None	Nothing

*Note: this assumes that either GSM to GPS time relation is not included to the assistance data, or the MS manages to utilize the GSM to GPS time relation in the previous cell before the occurrence of the HO.

#Note: The standard should allow the MS to send either the measurement response (with valid measurement data), or an error indication (in case the MS cannot perform satisfactory measurements under the new serving BTSs).

[0025] In order to avoid termination of an ongoing LCS procedure due to an occurrence of some RR procedure (e. g. HO or CRS), the LCS process (with the required parameters) is preferably continued from the current serving BSC/ RNC/SMLC and MSC(server)/SGSN to the new serving entities with a relocation procedure. It is noted that for the case of intra-BSC procedures this is not required, but the termination of the LCS procedure was not avoidable in R98 and R99 as the MS 100 was required to behave in some predictable manner irrespective of whether there is an inter-BSC/CRS or intra-BSC handover/CRS.

[0026] It is preferred that the positioning procedure never be terminated in the case of HO, CRS or some other RR procedure, if the measurement command has been delivered successfully to the MS 100. If the HO or CRS should occur during the transfer of a measurement command (or assistance data) to the MS 100 the positioning procedure

may be terminated, or it may be continued, possibly at the choice of the network operator.

Relocation Procedure with LCS Data

[0027] Fig. 4 provides an example of the relocation procedure with LCS data for the case of the Cell Reselection (PS domain) in accordance with an aspect of this invention. Fig. 4 maybe contrasted with the conventional procedure depicted in Fig. 3. In Fig. 4, the MS 100 can be seen to perform a cell update in the new cell first, and after that to send a response to the GPS/E-OTD measurement command (see Step 12X). Other improvements and modifications to the conventional Cell Reselection (PS domain) procedure are made apparent in the ensuing description of Fig. 4. Note should be made, however, that these teachings are not limited for use only with the illustrated Combined Cell/URA/GRA Update and SRNS Relocation procedure for the PS domain procedure, but can be applied as well, by example, to the Combined Hard Handover and SRNS Relocation procedure for the PS domain shown in Fig. 2, and also to the Combined Hard Handover and SRNS Relocation procedure for the CS domain. These teachings apply as well to LCS Reselection in an IP RAN architecture, as will be discussed below.

[0028] Referring now to the enumerated process steps shown in Fig. 4, a description of each step is now provided.

1) After having made cell re-selection, the MS 100 sends a Cell Update/URA/GRA Update message to the UTRAN or, in accordance with an aspect of these teachings, to the GERAN. Upon reception of the message, the target RNC/BSC forwards the received message towards the source SRNC via Iur (note that in the following signal flow description a reference to RNC denotes as well the BSC for the GERAN case). The source SRNC then decides to perform a Combined Cell/URA/GRA Update and SRNS Relocation towards the target RNC.

2) The source SRNC initiates the relocation preparation procedure by sending a Relocation Required message (Relocation Type, Cause, Source ID, Target ID, Source RNC to Target RNC Transparent Container) to the old (previous) SGSN. The source SRNC sets the Relocation Type to "UE not involved". The Source RNC to Target RNC Transparent Container includes the necessary information for Relocation co-ordination, security functionality, and RRC protocol context information (including UE Capabilities).

In accordance with an aspect of this invention, the LCS parameters (e.g., requested LCS QoS, what positioning procedure is active, details of the currently ongoing location process, GMLC Address of the active positioning procedure) may be included in the Relocation Required message in the Source RNC to Target RNC Transparent Container. Note in this regard that the LCS QoS includes, for example, the required location accuracy and the response time. Another, less preferred technique is described below with respect to Step 7.

3) The old SGSN determines from the Target ID if the SRNS Relocation is an intra-SGSN SRNS relocation or an inter-SGSN SRNS relocation. In case of inter-SGSN SRNS relocation the old SGSN initiates the relocation resource allocation procedure by sending a Forward Relocation Request (IMSI, Tunnel Endpoint Identifier Signalling, MM Context, PDP Context, Target Identification, UTRAN Transparent Container, RANAP Cause) message to the new SGSN. At the same time a timer is started on the MM and PDP contexts in the old SGSN, as specified in the Routeing Area Update procedure in the subclause Location Management Procedures (UMTS Only) found in 3G TS 23.060. The Forward Relocation Request message is applicable only in the case of the inter-SGSN SRNS relocation.

4) The new SGSN sends a Relocation Request message (Permanent NAS UE Identity, Cause, CN Domain Indicator, Source RNC to Target RNC Transparent Container, RABs To Be Setup) to the target RNC. For each RAB requested to be established, RABs To Be Setup contain information such as RAB ID, RAB parameters, Transport Layer Address and Iu Transport Association. The RAB ID information element contains the NSAPI value, and the RAB parameters information element gives the QoS profile. The Transport Layer Address is the SGSN Address for user data, and the Iu Transport Association corresponds to Tunnel Endpoint Identifier Data.

After all necessary resources for accepted RABs, including the Iu user plane, are successfully allocated, the target RNC sends the Relocation Request Acknowledge (RABs setup, RABs failed to setup) message to the new SGSN. The target RNC, for each RAB to be setup (defined by an IP Address and a Tunnel Endpoint Identifier), receives both forwarded downstream PDUs from the source SRNC as well as downstream PDUs from the new SGSN.

5)When resources for the transmission of user data between the target RNC and the new SGSN have been allocated, and the new SGSN is ready for relocation of SRNS, the Forward Relocation Response message (Cause, RANAP Cause, and Target RNC Information) is sent from new SGSN to old SGSN. This message indicates that the target RNC is ready to receive from the source SRNC the downstream packets not yet acknowledged by the MS 100, i.e., the relocation resource allocation procedure is terminated successfully. RANAP Cause is information

from the target RNC to be forwarded to the source RNC. The RAB Setup Information, one information element for each RAB, contains the RNC Tunnel Endpoint Identifier and RNC IP address for data forwarding from the source SRNC to target RNC. If the target RNC or the new SGSN failed to allocate resources the RAB Setup Information element contains only the NSAPI indicating that the source RNC is to release the resources associated with the NSAPI. The Forward Relocation Response message is applicable only in the case of inter-SGSN SRNS relocation.

6) The old SGSN continues the relocation of SRNS by sending a Relocation Command (RABs to be released, and RABs subject to data forwarding) message to the source SRNC. The old SGSN determines the RABs subject to data forwarding based on QoS, and those RABs are contained in RABs subject to data forwarding. For each RAB subject to data forwarding, the information element is specified to contain the RAB ID, Transport Layer Address and Iu Transport Association. The Transport Layer Address and Iu Transport Association is used for forwarding of DL N-PDU from the source RNC to the target RNC.

7) Upon reception of the Relocation Command message from the PS domain, the source RNC starts a data-forwarding timer. When the relocation preparation procedure is terminated successfully, and when the source SRNC is ready, the source SRNC triggers the execution of relocation of SRNS by sending a Relocation Commit (SRNS Contexts) message to the target RNC. The purpose of this procedure is to transfer SRNS contexts from the source RNC to the target RNC. SRNS contexts are sent for each concerned RAB and contain the sequence numbers of the GTP-PDUs next to be transmitted in the uplink and downlink directions, and the next PDCP sequence numbers that would have been used to send and receive data from the MS 100. For connections using the RLC unacknowledged mode the PDCP sequence number is not used.

In accordance with these teachings, and as was discussed above in Step 2, the LCS parameters may be included in the Relocation Commit message, although this technique is not presently more preferred than including the LCS parameters in the Relocation Required message in the Source RNC to Target RNC Transparent Container.

8) After having sent the Relocation Commit message, the source SRNC begins the forwarding of data for the RABs subject to data forwarding. The data forwarding at SRNS relocation is carried out through the Iu interface, meaning that the data exchanged between the source SRNC and the target RNC are duplicated in the source SRNC and are routed at the IP layer towards the target RNC.

9) The target RNC sends a Relocation Detect message to the new SGSN when the relocation execution trigger is received. For the SRNS relocation type UE Not Involved, the relocation execution trigger is the reception of the Relocation Commit message from the Iur interface. When the Relocation Detect message is sent, the target RNC starts SRNC operation.

10) After having sent the Relocation Detect message, the target SRNC responds to the MS 100 by sending a Cell Update Confirm/URA/GRA Update Confirm message. Both messages contain UE information elements and CN information elements. The UE information elements include among other information the new SRNC identity and S-RNTI. The CN information elements contain among other information the Location Area Identification and Routing Area Identification. This procedure is co-ordinated in all Iu signalling connections existing for the MS.

11) Upon reception of the Relocation Detect message, the CN may switch the user plane from the source RNC to the target SRNC. If the SRNS Relocation is an inter-SGSN SRNS relocation, the new SGSN sends Update PDP Context Request messages (new SGSN Address, SGSN Tunnel Endpoint Identifier, QoS Negotiated) to the GGSNs concerned. The GGSNs update their PDP context fields and return an Update PDP Context Response (GGSN Tunnel Endpoint Identifier) message.

12) When the MS 100 has reconfigured itself, it sends the RNTI Reallocation Complete message to the target SRNC.

12X) In accordance with these teachings, if some positioning procedure was ongoing in the MS 100, the MS 100 sends the response message including successful measurement reports or a failure indication. The message may be sent before of after sending the RNTI Reallocation Complete message. In this manner the ongoing MS 100 positioning procedure is not required to be terminated, thereby overcoming the problems that were discussed above. The measurement results message may be sent by the mobile station before or after sending a GERAN/UTRAN Mobility Information Confirm message from the mobile station to the target BSC/RNC.

13) When the target SRNC receives the RNTI Reallocation Complete message, i.e., the new SRNC-ID + S-RNTI

are successfully exchanged with the UE by the radio protocols, the target SRNC initiates the Relocation Complete procedure by sending the Relocation Complete message to the new SGSN. The purpose of the Relocation Complete procedure is to indicate by the target SRNC the completion of the relocation of the SRNS to the CN. If the user plane has not been switched at Relocation Detect, the CN upon reception of Relocation Complete switches the user plane from the source RNC to the target SRNC. If the SRNS Relocation is an inter-SGSN SRNS relocation, the new SGSN signals to the old SGSN the completion of the SRNS relocation procedure by sending a Forward Relocation Complete message.

14) Upon receiving the Relocation Complete message, or if it is an inter-SGSN SRNS relocation, the Forward Relocation Complete message, the old SGSN sends an Iu Release Command message to the source RNC. When the RNC data-forwarding timer started in Step 7 expires the source RNC responds with an Iu Release Complete.

15) After the MS 100 has finished the Cell/URA/GRA update and RNTI reallocation procedure, and if the new Routing Area Identification is different from the old, the MS 100 initiates the Routing Area Update procedure. See in the regard the subclause Location Management Procedures (UMTS Only). Note that it is only a subset of the RA update procedure that is performed, since the MS 100 is in the PMM-CONNECTED state.

LCS Relocation in IP RAN Architecture

[0029] A discussion is now made of the positioning signaling flow in a particular IP RAN architecture. Reference can also be made to Fig. 5 for a discussion of the positioning signaling flow.

[0030] It should be noted, however, that this procedure need not be IP RAN specific, and could be employed as a normal positioning procedure in UTRAN (or GERAN) by replacing references to Radio Network Access Server (RNAS) with RNC. It should be noted that the RNAS functionality can be integrated into the BTS functionality.

1) The SGSN/MSC server sends a Location Request to the RNAS.

2) The RNAS knows in which cell the MS 100 is located, or pages the MS 100 to determine the current cell where the MS 100 is located. If the Location Request only requires the service area id the RNAS may send this directly to the SGSN/MSC server without involving the SMLC.

3) The RNAS sends a Location Request to the SMLC. The SMLC determines if the cell accuracy (with possible other available information, such as the current Timing Advance value and the received signal level) is sufficient, and then translates the cell id (and possibly the other avaiable information) into MS 100 location coordinates. Ifbetter accuracy is required, the SMLC requests the RNAS to obtain measurement results of the target MS 100.

4) The RNAS sends a measurement request to the target MS 100.

5) The target MS 100 sends the measurement results to the RNAS.

6) The RNAS sends the measurement results to SMLC.

7) The SMLC requests measurement results from the LMU (or the LMU reports periodically to the SMLC, in which case this step and the next step (8) can be omitted).

8) The LMU sends the measurement results to the SMLC

9) The SMLC calculates the location of the target MS 100.

10) The SMLC sends the location calculation results to the RNAS.

11) The RNAS sends the location result to the SGSN/MSC server.

[0031] The IP RAN Architecture has some effect on the LCS relocation procedure in the HO/CRS case. In the IP RAN architecture the SMLC and possibly the RNAS may be maintained the same during the positioning procedure regardless of the HO or CRS (i.e., the occurrence of the HO or CRS does not require a change in the RNAS or the SMLC). This means that in the IP RAN architecture the relocation procedure with the transfer of the LCS parameters is not required, if the RNAS is not changed. In the case where the RNAS is changed, the SMLC would still be the same,

and in this case the new RNAS is required to find the SMLC. This can be accomplished if during the relocation procedure the address of the SMLC is transported from the old RNAS to the new RNAS.

[0032] It should be noted that absent the use of this invention the MS 100 will always abort the positioning procedure in the case of HO or CRS. This applies as well to the IP RAN architecture discussed above.

[0033] It should be appreciated that the improved LCS procedure in accordance with these teachings does not prematurely terminate as often as in the prior art due to an occurrence of some HO, CRS, or other RR procedure, and thereby provides reduced average delays, lower power consumption in the MS 100, and improved service to the end user.

[0034] While described in the context of presently preferred and exemplary embodiments of these teachings, those skilled in the art will recognize that changes in form and details may be made, and that these changes will still fall within the scope of these teachings.

Claims

1. A method for operating a mobile station in cooperation with a network operator, comprising:

   upon an occurrence of a RR procedure, including HO and CRS, that affects the mobile station, determining if a location procedure is ongoing in the mobile station; and

   if it is, completing the location procedure and reporting measurement results in a message from the mobile station to a target radio network controller.

2. A method as in claim 1, wherein the location procedure is executed during a Combined Hard Handover and SRNS Relocation procedure for at least one of a PS or a CS domain, and applies to both intra-SGSN/MSC SRNS relocation and inter-SGSN/MSC and SRNS relocation.

3. A method as in claim 1, wherein the location procedure is executed during a Combined Cell/URA/GRA Update and SRNS Relocation procedure for a PS domain, and applies to both intra-SGSN SRNS relocation and for inter-SGSN SRNS relocation

4. A method as in claim 1, further comprising sending LCS parameters from a source RNC/BSC to a target RNC/BSC.

5. A method as in claim 4, wherein the LCS parameters are sent in a transparent manner.

6. A method as in claim 4, wherein for a UTRAN case the LCS parameters are sent in a Source RNC to Target RNC Transparent Container in a Relocation Required message.

7. A method as in claim 1, further comprising sending LCS parameters from a source RNC/BSC to a target RNC/BSC in a Relocation Commit message.

8. A method as in claim 1, further comprising sending LCS parameters to the target RNC in a Forward SRNS Context message.

9. A method as in claim 5, where the LCS parameters comprise at least one of:

   a requested location accuracy;

   a requested location response time;

   details pertaining to a currently ongoing location process; and

   a GMLC address.

10. A method as in claim 6, where the LCS parameters comprise at least one of:

    a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

11. A method as in claim 7, where the LCS parameters comprise at least one of:

a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

12. A method as in claim 8, where the LCS parameters comprise at least one of:

a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

13. A method as in claim 1, wherein the message is sent before sending a UTRAN Mobility Information Confirm message from the mobile station to the target RNC/BSC.

14. A method as in claim 1, wherein the message is sent after sending a UTRAN Mobility Information Confirm message from the mobile station to the target RNC/BSC.

15. A wireless communications system having at least one mobile station for communicating with a network operator, comprising a controller in said mobile station, responsive to an occurrence of a RR procedure, including HO and CRS, that affects the mobile station, for determining if a location procedure is ongoing in the mobile station and, if it is, for completing the location procedure and for reporting measurement results in a message transmitted from the mobile station to a target radio network controller.

16. A system as in claim 15, wherein the location procedure is executed during a Combined Hard Handover and SRNS Relocation procedure for at least one of a PS or a CS domain, and applies to both intra-SGSN/MSC SRNS relocation and inter-SGSN/MSC and SRNS relocation.

17. A system as in claim 15, wherein the location procedure is executed during a Combined Cell/URA/GRA Update and SRNS Relocation procedure for a PS domain, and applies to both intra-SGSN SRNS relocation and for inter-SGSN SRNS relocation

18. A system as in claim 15, where the system sends LCS parameters from a source RNC/BSC to a target RNC/BSC.

19. A system as in claim 18, wherein the system sends LCS parameters in a transparent manner.

20. A system as in claim 18, wherein for a UTRAN case the system sends LCS parameters in a Source RNC to Target RNC Transparent Container in a Relocation Required message.

21. A system as in claim 15, where the system sends LCS parameters from a source RNC/BSC to a target RNC/BSC in a Relocation Commit message.

22. A system as in claim 15, where LCS parameters are sent to a target RNC/BSC in a Forward SRNS Context message.

23. A system as in claim 19, where the LCS parameters comprise at least one of:

a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

24. A system as in claim 20, where the LCS parameters comprise at least one of:

a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

25. A system as in claim 21, where the LCS parameters comprise at least one of:

a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

26. A system as in claim 22, where the LCS parameters comprise at least one of:

a requested location accuracy;

a requested location response time;

details pertaining to a currently ongoing location process; and

a GMLC address.

27. A system as in claim 15, where the message is transmitted before transmitting a UTRAN Mobility Information Confirm message from the mobile station to the target RNC/BSC.

28. A system as in claim 15, where the message is transmitted after transmitting a UTRAN Mobility Information Confirm message from the mobile station to the target RNC/BSC.

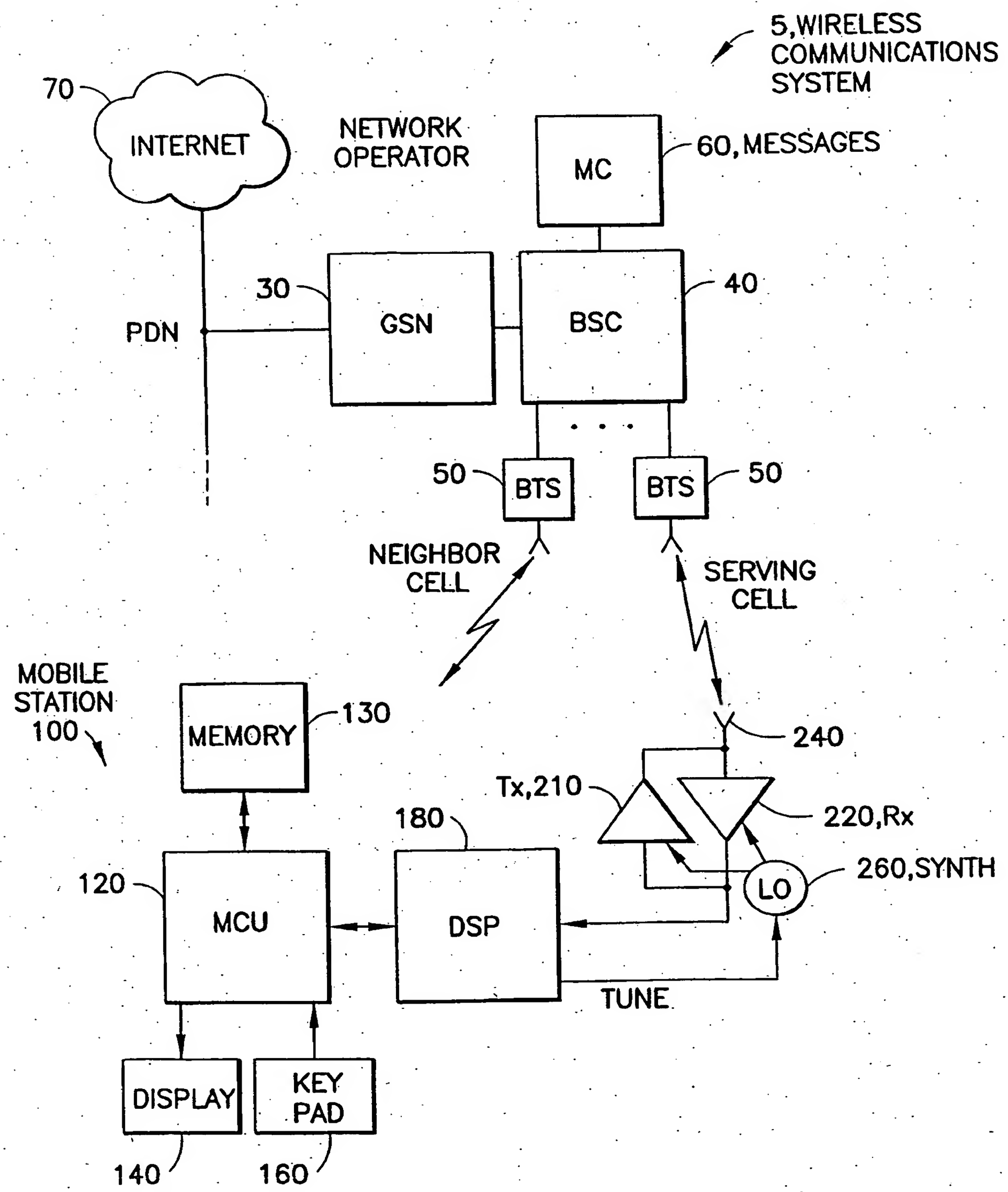
5,WIRELESS COMMUNICATIONS SYSTEM
70
INTERNET
NETWORK OPERATOR
MC
60,MESSAGES
30
GSN
BSC
40
PDN
50
BTS
BTS
50
NEIGHBOR CELL
SERVING CELL
MOBILE STATION 100
MEMORY
130
240
Tx,210
220,Rx
180
120
MCU
DSP
LO
260,SYNTH
TUNE
DISPLAY
KEY PAD
140
160

FIG.1

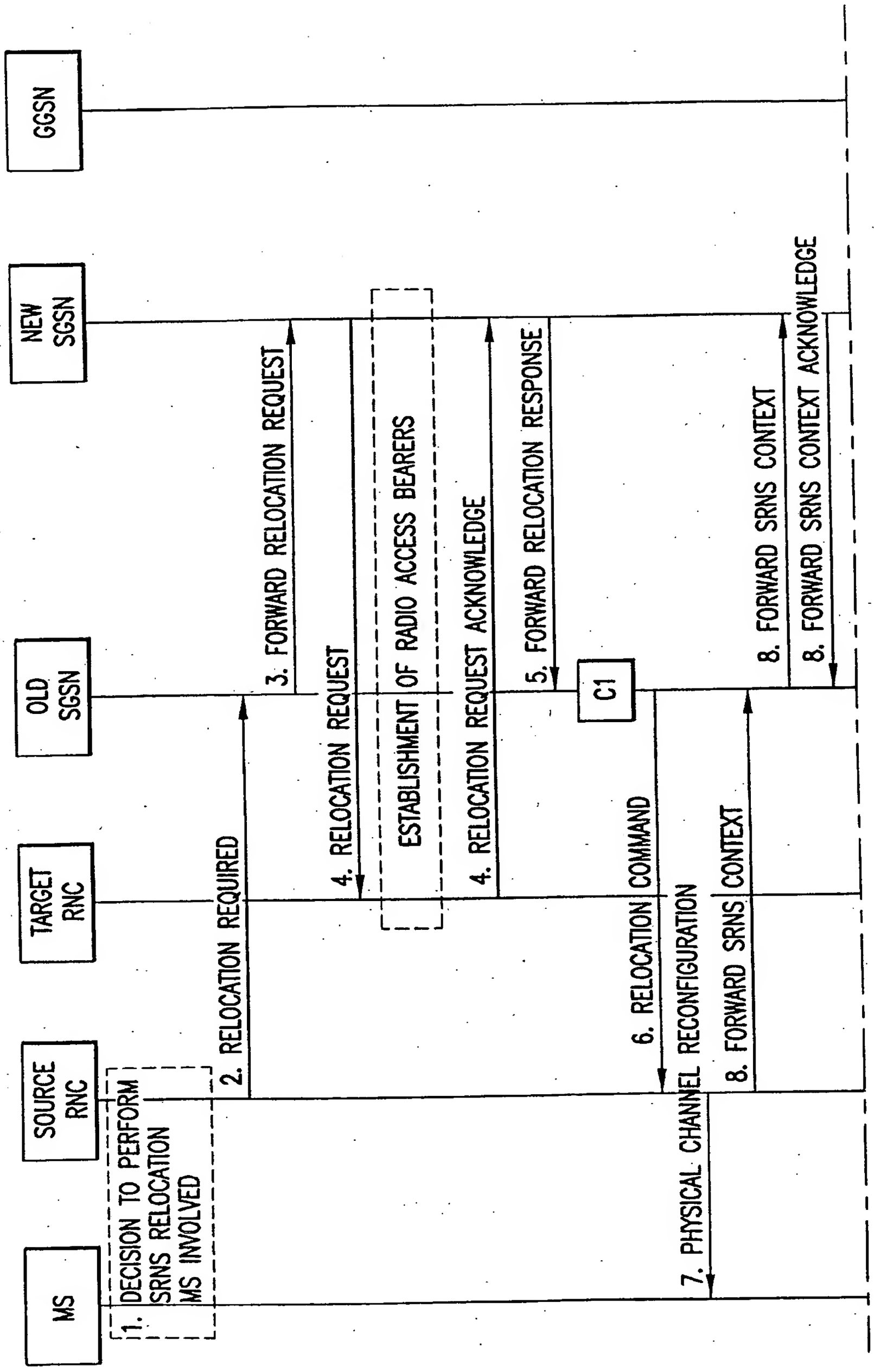

FIG.2A
PRIOR ART

FIG.2

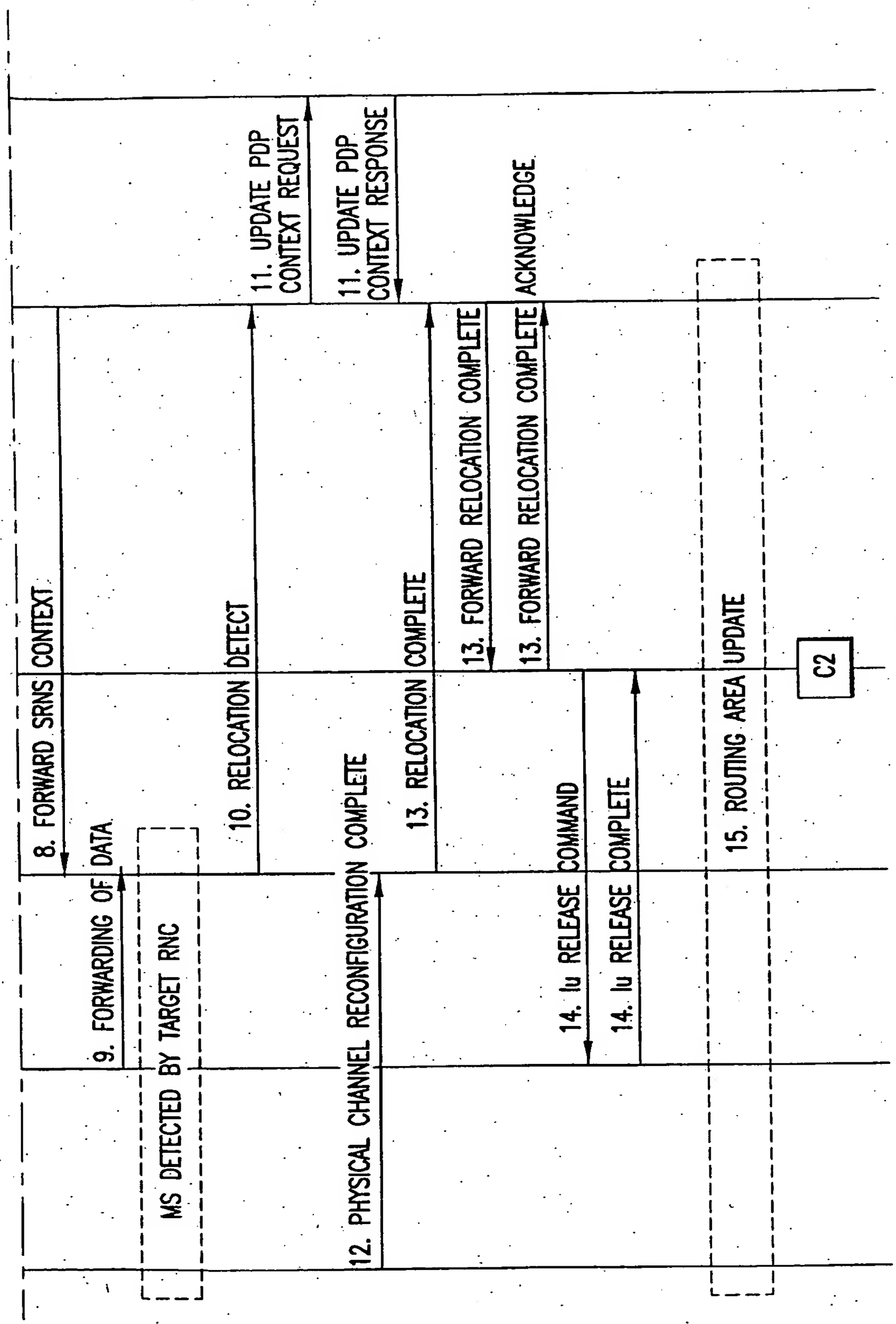

FIG.2B
PRIOR ART

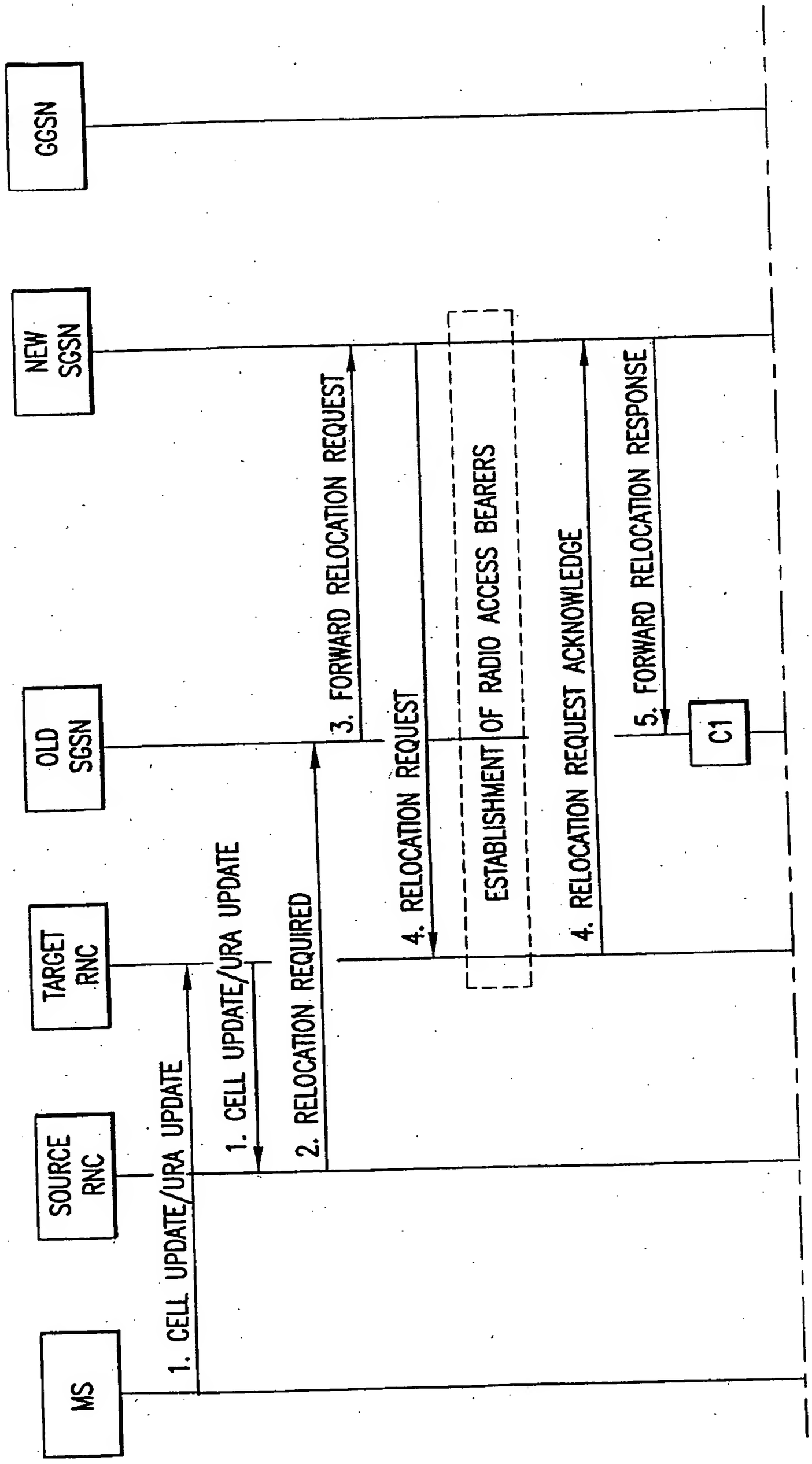

FIG.3A
PRIOR ART

FIG.3

FIG.3A
FIG.3B

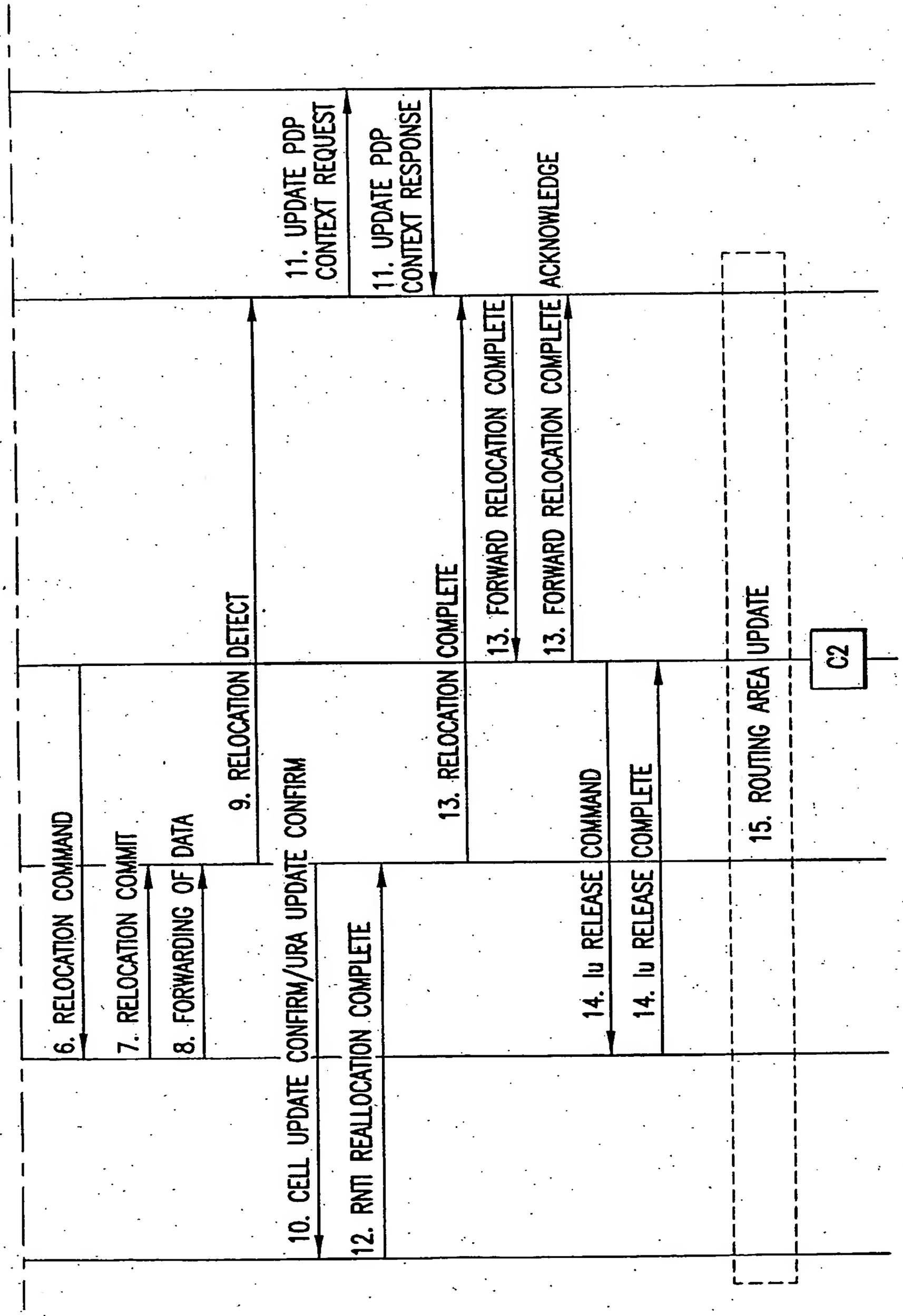

FIG.3B
PRIOR ART

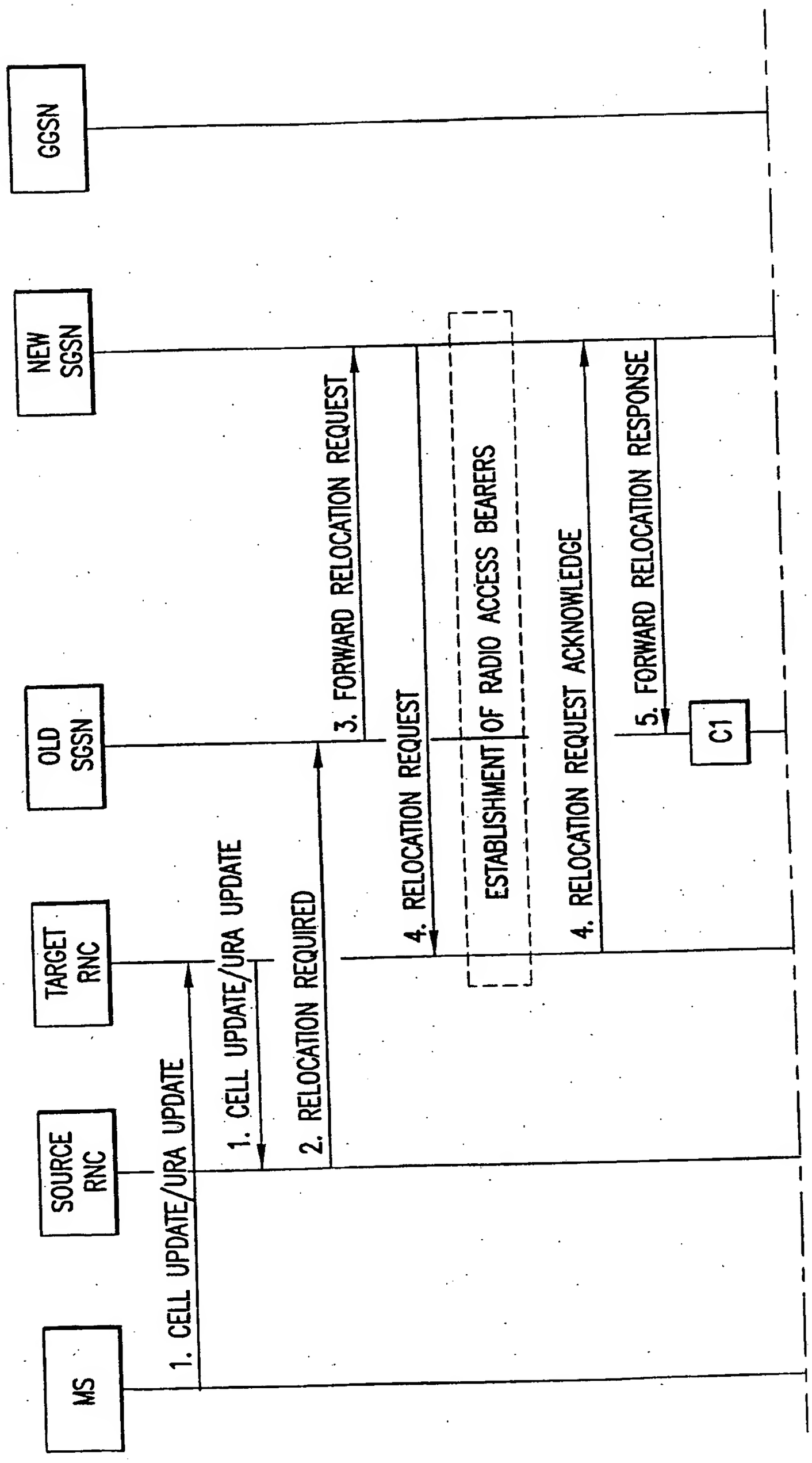

FIG.4A

FIG.4B

FIG.4

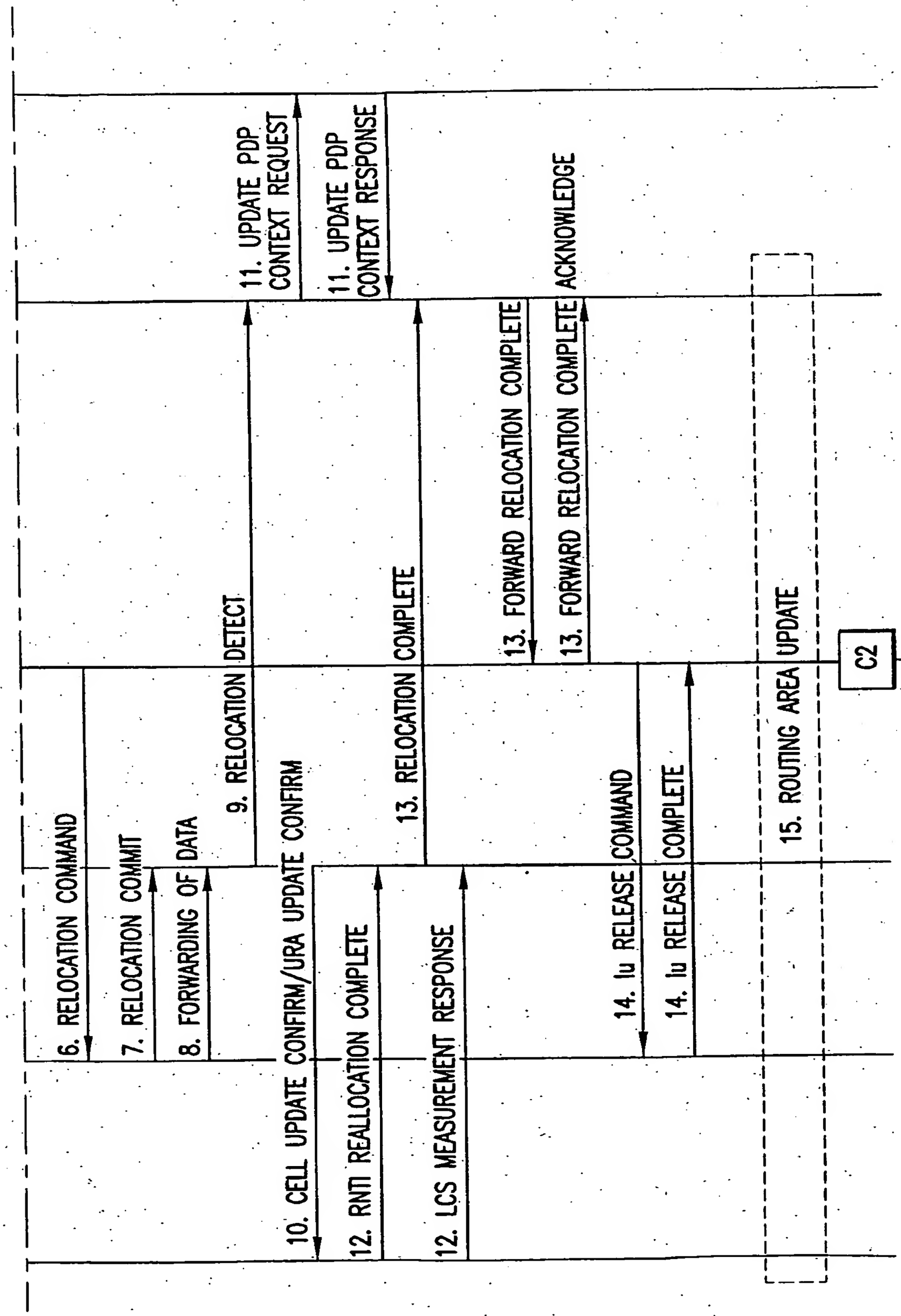
11. UPDATE PDP CONTEXT REQUEST
11. UPDATE PDP CONTEXT RESPONSE
ACKNOWLEDGE
6. RELOCATION COMMAND
7. RELOCATION COMMIT
8. FORWARDING OF DATA
9. RELOCATION DETECT
10. CELL UPDATE CONFIRM/URA UPDATE CONFIRM
12. RNTI REALLOCATION COMPLETE
12. LCS MEASUREMENT RESPONSE
13. RELOCATION COMPLETE
13. FORWARD RELOCATION COMPLETE
13. FORWARD RELOCATION COMPLETE
14. Iu RELEASE COMMAND
14. Iu RELEASE COMPLETE
15. ROUTING AREA UPDATE
C2

FIG.4B

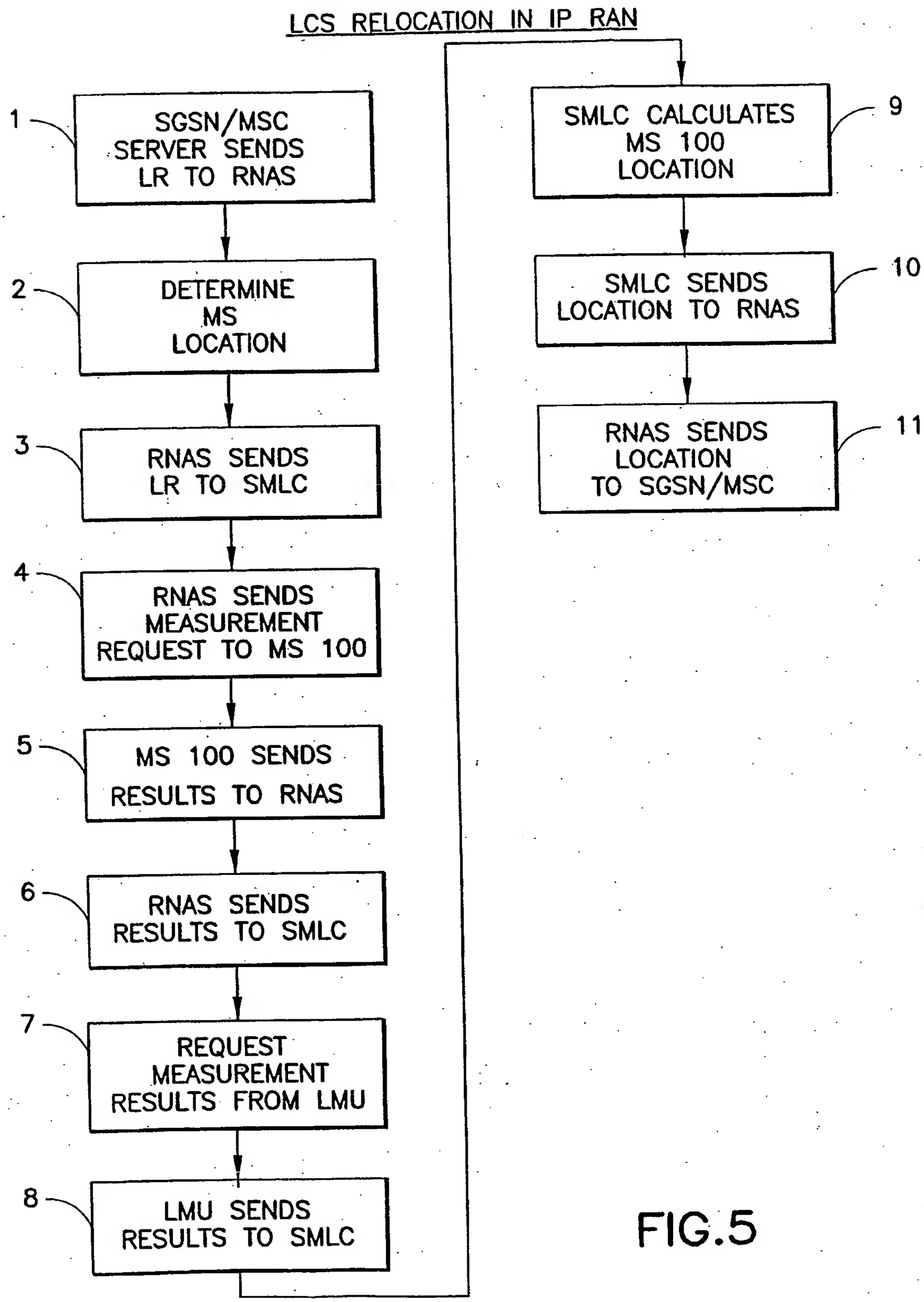
LCS RELOCATION IN IP RAN
1
SGSN/MSC SERVER SENDS LR TO RNAS
2
DETERMINE MS LOCATION
3
RNAS SENDS LR TO SMLC
4
RNAS SENDS MEASUREMENT REQUEST TO MS 100
5
MS 100 SENDS RESULTS TO RNAS
6
RNAS SENDS RESULTS TO SMLC
7
REQUEST MEASUREMENT RESULTS FROM LMU
8
LMU SENDS RESULTS TO SMLC
9
SMLC CALCULATES MS 100 LOCATION
10
SMLC SENDS LOCATION TO RNAS
11
RNAS SENDS LOCATION TO SGSN/MSC

FIG.5